551.5 Payment

No separate payment will be made for pipe protection. Include all costs incurred in complying with this Specification in the price bid for the piling.

551.5.01 Adjustments

General Provisions 101 through 150.

Section 555—Tunnel Liner

555.1 General Description

This work includes:

- Driving a tunnel
- Furnishing and installing steel plates for tunnel liner
- Furnishing and erecting brick portals to close each end of the tunnel, when required
- Pressure grouting

Construct to Plan line, grade, and dimensions, according to the applicable Specifications.

555.1.01 Definitions

General Provisions 101 through 150.

555.1.02 Related References

A. Standard Specifications

Section 608—Brick Masonry

Section 615—Jacking or Boring Pipe

Section 645—Repair of Galvanized Coatings

Section 834—Masonry Materials

Section 844—Steel Pipe

B. Referenced Documents

AASHTO Design Specification for Tunneling

AASHTO Standard Specifications for Highway Bridges, Section 26

Manual on Uniform Traffic Control Devices

ASTM A 569/A 569M

555.1.03 Submittals

A. Special Permit Application

Before working with explosives, apply to the Department for a special permit. This permit will be in addition to a tunneling permit not involving explosives.

Special permits will be issued when the proposed operational procedures outlined in the permit form are submitted and approved.

B. Design Data

For Projects not under Contract to the Department but are being performed under permit, the owner shall submit complete design data including working or Shop Drawings for approval before receiving the permit. Include the following applicable design data:

- Design data as required by AASHTO design specification for tunneling
- Subsoil surveys, including the elevation of the water table and the classification and relative density of the soils from the ground line to 3 ft (1 m) below the tunnel liner

- Rock coring data, including rock type and core recovery, where required
- Water control plans, where required

C. Repair Plan

If tunneling damages the roadway, submit a roadway repair plan for approval.

555.2 Materials

Ensure that materials meet the following requirements:

Material	Specification Section
Liner Plates	ASTM: A 569/A 569M
Galvanizing Bituminous Coating and Bolts	844
Brick for Portal	608 834.2.01

A. Liner Plates

Construct the completed liner with a series of steel liner plates assembled with staggered longitudinal joints and fabricated to fit the tunnel cross section.

1. Characteristics

   Use hot-dipped galvanized, bituminous-coated steel of the size, thickness, and sectional modulus specified.

   Use plates made of hot-rolled, cold-formed steel that conform to ASTM A 569/A 569 M. Use plates with the following mechanical properties before cold forming:

   - Tensile strength = 42,000 psi (290 MPa)
   - Yield strength = 28,000 psi (190 MPa)
   - Elongation, 2 in (50 mm) = 30 percent

2. Grout Intrusion Nipples

   Provide grout intrusion nipples 2 in (50 mm) or larger in diameter in the top plates at intervals 10 ft (3 m) or less. This will permit grouting while the tunnel liner is erected. For larger tunnels, or where conditions make more grout openings advisable, install additional plates with nipples at the top quarter points and/or on each side between the top openings. Stagger these additional openings, but keep the distance between them 10 ft (3 m) or less in any one line.

3. Flanged Joints

   Form plates to provide circumferential flanged joints. Use longitudinal joints that are flanged or offset lap seam type.

   Punch plates for bolting on both longitudinal and circumferential seams or joints.

   Space bolts in circumferential flanges according to the manufacturer's standard spacing. Space bolts a multiple of the plate length so that plates with the same curvature are interchangeable and will permit staggering of longitudinal seams.

4. Longitudinal Seams

   For lapped longitudinal seams, ensure that bolt size and spacing is according to the manufacturer's standard, but meets the longitudinal seam strength requirements of Section 16 of AASHTO Standard Specifications for Highway Bridges. Galvanizing Bituminous Coating and Bolts shall be in compliance with applicable information in Section 844.

B. Grout

Use grout that consists of:

- One part Portland cement
- Two parts masonry lime
- Four parts mortar sand
- Two percent of an approved admixture, (i.e., Bentonite, Septamine Stearex, or Hydrocide Liquid)
- A retardant, where required

Use enough mixing water to produce a workable mixture of grout capable of being pumped into the voids created by tunneling.

C. Brick

Brick for portal shall conform to Section 608 and Subsection 834.2.03.

555.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

555.3 Construction Requirements

555.3.01 Personnel

General Provisions 101 through 150.

555.3.02 Equipment

A. Pumping Equipment

Provide pumping equipment for grouting operations. Use equipment with enough pump horsepower and grouting line pressure to completely fill voids without buckling or shifting the liner plates or damaging the roadway.

B. Water Control

When water control is required, operate well points or other drainage systems in the vicinity of the tunnel construction limits.

555.3.03 Preparation

General Provisions 101 through 150.

555.3.04 Fabrication

General Provisions 101 through 150.

555.3.05 Construction

Excavate the tunnel using any of the following procedures:

- Full face
- Heading and bench
- Multiple drift

Do not use a full or partial shield, a tunneling machine, or other equipment that exerts a force on the liner plates to propel, steer, or stabilize the equipment.

Prevent the overpassing roadway or railway section from settling when constructing tunnels by using:

- Poling plates
- Brest boards
- Shields
- Soil solidification
- A combination of these methods

A. Installation of Liner Plates

Use the same type of liner plates for the full length of the tunnel. Flanged and lapped seam methods of construction are acceptable.

1. General

   Install self-supporting steel liner plates according to the manufacturer's recommendations. Do not leave more than 5 ft (1.5 m) of tunnel unlined while tunneling. Do not leave more than 1 ft (300 mm) of tunnel unlined at the end of the day's operation.

2. Sealing

   Before grouting tunnel liner segments, seal that segment sufficiently between the liner plates and the surrounding soil to retain the grouting pressure. Place the seals in these locations:

   - At the tunnel entrance

- Between grout intrusion nipples
- Within 1 ft (300 mm) of the end of the tunnel

3. Pressure Grouting

   Pressure grout voids in the area outside the plates every 10 ft (3 m) at the end of the work shift. Grout more frequently if soil conditions dictate.

4. Repair

   Repair damaged spelter coating according to Section 645. Replace plates with damaged spelter or bituminous coatings at no additional cost to the Department if the Engineer determines they cannot be repaired.

B. Safety

Schedule the Work to avoid interfering with or endangering traffic flow on the highway or railway. Follow required safety measures specified in the Manual on Uniform Traffic Control Devices.

1. Begin tunneling at one end of a pit that has been sheeted and shored as necessary. Comply with Section 615. Perform work below the level of the roadbed.
2. Complete tunneling at one location before beginning work at another.
3. If the Engineer determines that tunneling is endangering overpassing roadway or the traveling public, stop tunneling until making the necessary corrections.
4. Provide a well-braced, temporary bulkhead against the face of the excavation when work stops while the heading is within 20 ft (6 m) of railroad tracks or highway pavement.
5. If distress occurs to roadway due to tunneling, the Contractor shall submit for approval a Plan to repair the roadway.

C. Portals

Close tunnel portals at each end using a three-course mortared brick wall according to Plan details. Erect one of the three courses inside the liner.

555.3.06 Quality Acceptance

Ensure that the tunnel has a diameter essentially the same as the outside diameter of the liner plates.

555.3.07 Contractor Warranty and Maintenance

General Provisions 101 through 150.

555.4 Measurement

Tunnel liner installed according to the approved design and these Specifications is measured by the linear foot (meter) complete in place. The liner is measured between the ends of the liner along the invert.

555.4.01 Limits

Portals are not measured for separate payment.

555.5 Payment

This Work, measured as specified above, will be paid for at the Contract Unit Price bid per linear foot (meter) of liner for each diameter and plate thickness. The specified thickness is used for either a two-flange plate or a four-flange plate.

This payment will be full compensation for:

- Furnishing materials, labor, tools, and equipment
- Removing and satisfactorily disposing of all excavated materials
- Force grouting
- Providing tunnel portals, where required
- Restoring and cleaning, including regrassing, as required
- Installing liner

Payment will be made under:

Item No. 555	Tunnel liner ___ diameter, ___ plate thickness (2 flange), or ___ plate thickness (4 flange)	Per linear foot (meter)

555.5.01 Adjustments

General Provisions 101 through 150.

Section 560—Structural Plate Pipe, Pipe-Arch and Arch Culverts

560.1 General Description

This work includes furnishing and installing structural plate pipe, pipe-arch, and arch culverts. Use the type of structural plate structure shown on the Plans.

Install structures according to the Specifications and to Plan details, or as directed by the Engineer.

560.1.01 Definitions

General Provisions 101 through 150.

560.1.02 Related References

A. Standard Specifications

Section 205—Roadway Excavation

Section 207—Excavation and Backfill for Minor Structures

Section 208—Embankments

Section 645—Repair of Galvanized Coatings

Section 840—Corrugated Aluminum Alloy Pipe

Section 844—Steel Pipe

B. Referenced Documents

General Provisions 101 through 150.

560.1.03 Submittals

General Provisions 101 through 150.

560.2 Materials

Ensure that materials meet the requirements of the following Specifications:

Material	Section
Backfill Materials	207
Steel Structural Plate for Pipe, Pipe-Arches, and Arches	844.2.03
Corrugated Aluminum Alloy Structural Plate Pipe, Pipe-Arches and Arches	840.2.04

560.2.01 Delivery, Storage, and Handling

General Provisions 101 through 150.

560.3 Construction Requirements

560.3.01 Personnel

General Provisions 101 through 150.

560.3.02 Equipment

General Provisions 101 through 150.

560.3.03 Preparation

Prepare structure excavation and foundation according to Section 207.

Before installing structural plate pipe, pipe-arch, or arch culverts, shape their foundation material as shown on the Plans.